A COMPREHENSIVE MODEL FOR ENERGY TRANSPOT AND ABLATION OF METAL FILMS INDUCED BY ULTRASHORT PULSED LASERS

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ABSTRACT

A comprehensive laser material ablation model was developed to describe energy transport, ultrafast phase changes, and material ablation of metal films irradiated by ultrashort laser pulses. The two optical models were incorporated into the TTM to simulate laser energy deposition and the resulting thermal response, ultrafast phase changes from solid to liquid and from liquid to vapor, and phase explosion of metal films irradiated by ultrashort laser pulses. It was found that dynamic optical properties could play a very important role in modeling ultrashort-pulsed laser interactions with metal materials.

In the semi-classical TTM, due to the effect of electron drifting, slightly lower electron and lattice temperatures were obtained compared to those calculated by the classical TTM under the same laser irradiation conditions. Higher laser fluence and longer pulse duration could result in more distinct difference between the two models.

For multi-pulse irradiations, the results showed that with the same total energy in a laser burst, more pulses with a shorter separation time, e.g., 1 ps, or fewer pulses with a longer separation time, e.g., 100 ps, could achieve higher lattice temperature.

Results of laser material ablations show that for high laser fluences phase explosion is a dominating mechanism in material ablation. The simulated ablation depths correlated very well with existing experimental data over a broad range of fluences, 0.6 – 30 J/cm^2.